

the brighter portions of comets, and has obtained for many of these bodies lines which resemble the spectrum of carbon, as taken in a hydrocarbon.

In Fig. 22 we have, first, the spectrum of Brorsen's comet; secondly, the spectrum of Winnecke's comet; thirdly, the spectrum of carbon in olefiant gas; fourthly, that of carbon in olive oil.

More recently the same observer has found other specimens of this class of bodies, which give spectra essentially different from the hydrocarbon type, and he remarks that as the meteors which come down to us differ greatly in chemical constitution, so it is not surprising that a similar difference should be found in comets which we know to be very closely allied to meteors.

Dr. Miller and Mr. Huggins were amongst the first to give us information regarding the spectra of stars. These bodies exhibit spectra very similar to that of the sun—that is to say, they give us an underlying continuous spectrum, intersected with dark lines. We have thus evidence of a similarity in physical constitution between our sun and these very distant bodies.

The position of the dark lines is the great object of interest in stellar spectra, and by the method already described the presence of various terrestrial elements has been detected in the stars.

In the most brilliant bluish-white stars, along with the presence of numerous fine lines, we have a comparatively small number of prominent absorption lines, the substances which these indicate as present being hydrogen, calcium, magnesium, and sodium. We shall return to this subject on a future occasion.

Miller and Huggins were so fortunate as to obtain the spectrum of a star which suddenly blazed out in May, 1866, and found in it the unmistakable presence of bright hydrogen lines.

Such a star is probably to be regarded as exhibiting on an enormous scale the same phenomenon which is frequently seen in the outburst of hydrogen from the interior of our luminary. Indeed, we have sometimes bright lines of hydrogen in the spectrum of certain solar regions. Padre Secchi has also ascertained that several very small stars exhibit bright lines.

I need hardly say that in the case of the fixed stars where the disc is a mere point, we have no possibility of differentiating between various portions of it, or of ascertaining the velocities of its atmospheric motions by spectral displacement.

We have, however, the means of ascertaining by this method whether the star be approaching us or receding from us, and how rapidly it is doing so. Huggins has made many laborious and interesting observations of this nature, and has determined the relative motion to or from us of many stars—a result which could not possibly be ascertained without the spectroscope.

In Fig. 23 we have an indication of the proper motion of Sirius as seen by the displacement of the hydrogen line F in the spectrum of that star.

Before concluding this branch of my subject, let me briefly allude to the light thrown by spectrum analysis on the composition of certain of the nebulae. On directing his stellar spectroscope to the planetary nebula in the constellation Draco on 20th August, 1864, Dr. Huggins found that its spectrum consisted of three bright lines on a dark background—in fine, that it was the spectrum of incandescent gas.

Of these three lines one is in all probability the hydrogen line H; another appears to coincide with one of the lines of nitrogen, while the third does not coincide with any known line.

Other nebulae have since been found by Huggins to give us similar spectra.

Fig. 24 denotes the general spectrum given by the nebulae.

It thus appears that we have already derived great

information regarding the constitution of the heavenly bodies by means of spectrum analysis.

BALFOUR STEWART

(To be continued.)

NOTES

THE death is announced, in his seventy-first year, of Dr. John Christopher Draper, Professor of Chemistry in the Medical Department of the University of the City of New York. Dr. Draper was the eldest son of the eminent Prof. John W. Draper. His scientific papers, apart from those on the science of medicine, are devoted to chemical and physical subjects; and among the latter chiefly to optical phenomena. His last one, relating to dark lines in the solar spectrum, attracted some attention at the time, 1878-79.

THE death is announced of Mr. James Fergusson, F.R.S., on the 9th inst., at the age of seventy-eight years. Mr. Fergusson was well known by his writings on Indian architecture, and also by his magnificent work on "Tree and Serpent Worship in India."

THE deaths among French Academicians have been unusually numerous of late; we have to record this week that of M. de Saint-Venant, a member of the Section of Geometry.

THE Russian Academy of Science has elected Mr. David Gill, Astronomer-Royal at the Cape of Good Hope, a Corresponding Member.

SEVERAL French papers have published articles on the opportunity of celebrating the centenary of Arago's birth, this celebrated astronomer and physicist having been born at Estagel, a country town of the Department of the Pyrénées Orientales, on Feb. 26, 1786. As he was a Copley Medallist and a foreign member of the Royal Society of London, it is expected that this Society will be invited to send a delegate to take part in the proceedings. Arago was elected a member of the Paris Academy at the early age of twenty-three, after having achieved the measurement of the meridian arc from Dunkirk to Formentera, for determining the length of the metre. His predecessor was Jerome de Lalande. In 1830 he was elected Perpetual Secretary, and he continued to act as such during twenty-three years up to his death, which took place in 1853. His works have been edited by Barral, and fill seventeen large octavo volumes, of which four are devoted to "Astronomie Populaire."

IN a very excellent article in *Science* on "The Government and its Scientific Bureaus," we find some wholesome remarks on the conditions under which scientific work can be performed at its best. "Science cannot be carried forward by prescribing too definitely the tasks of scientific men. They may be bound by appointed days and hours; they may be told to perform specific duties,—and if only the maintenance of routine work is required, such regulations may secure fidelity and efficiency. But if knowledge is to be advanced, if better methods of work are to be discovered, if greater accuracy is desired, if unknown facts are to be ascertained and recorded and discussed, and, in short, if there is to be real progress, the methods of freedom are to be employed, not those of petty regulation. By this we mean that if the great undertakings which the Government has in charge, if especially its surveys of the coast and of the interior are to go forward, discretion must be given to the chiefs of bureaus, and they must be held to accountability for the aggregate success of their work. Honesty, economy, clear and accurate statement of accounts are, of course, to be demanded in every office: nobody questions this. But the determination of what shall be undertaken in a given year, to whom it shall be assigned, what allowances shall be made for instruments, books, and assistants,—these are questions which experience and judgment must decide. Somebody who has all the facts in mind must make

the determination, and he must not be too quickly condemned, because the immediate results of the investigations which he has undertaken are not yet apparent. The highest personal character should be found in every one who is called upon to direct the labours of a scientific corps; he should be faithful, watchful, careful that all the interests intrusted to him may be promoted; but he should be free within the limitations of his office to select his subordinates, determine their duties, and prescribe their methods. Only by such regulated freedom as this can the highest results be obtained. Discretion with responsibility, in all the higher work of science, will bring the best services from those whose moral attitude is what it should be: no others should be intrusted with the leadership."

FROM the "Washington Letter" of *Science* we learn that in the retiring address of the President of the Chemical Society there Prof. F. W. Clarke gave "an able and entertaining *résumé* of the growth of chemistry in Washington during the past twelve or fifteen years." The President concluded with a plea for the establishment of a national laboratory, which, in its dimensions and equipment, should be commensurate with the importance and dignity of the science. Arguments to show the economy in, and the necessity for, such an establishment were not lacking, either in number or force. Examples of duplication or useless repetition of work, multiplication of instruments and facilities with no increase in efficiency, and frittering away time and energy on work properly belonging elsewhere, were given with a convincing emphasis, which made it a little difficult, at the close of the address, to believe that there were two sides to the question.

THE programme of the Congress of French Learned Societies for 1886 has been declared by a decree published by the Minister of Public Instruction. Amongst other subjects to be discussed by the fifth, or Natural Sciences Section, we find the following:—Study of the topographical distribution of the species inhabiting the French coasts; detailed study of the fluviatile fauna of France, indicating the species which are migratory and those which are permanent, and in the former case the dates of arrival and departure, noting also the time of laying the eggs, and the influence of the composition of the water; study of the migrations of birds, and of the periodical phenomena of vegetation, noting the coincidences of budding, flower, and maturity, with the appearance of the principal kinds of insects injurious to agriculture; the influence of winter temperatures on insects and their duration; study of honey- and wax-producing insects; a study, from an anthropological point of view, of the different populations which have occupied, in whole or part, a certain part of France since the most remote times; the course and duration of the great epidemics of the Middle Ages and of recent times; a comparison between the Tertiary vertebrates of the various French formations in view of the successive modifications which the types have undergone; a comparison of the Quaternary vertebrates with similar species of the present epoch; a comparison of the flora of the southern departments of France with that of Algiers; the Eucalyptus and its uses; the influence of the chain of the Cevennes in the propagation northwards of the Mediterranean species of plants and animals; a study of the general movements of sand in Asia and Africa, noting the region in which it is retreating and that in which it is advancing.

WE lately commented on a suggestion made, on economical grounds, that Jamaica should diminish the amount spent on, and by consequence the usefulness of, the Colonial Botanic Gardens. We are pleased to notice that similar views do not prevail elsewhere in the West Indian Islands, for at a late meeting of the Legislative Council of Grenada, the Governor announced that it had been decided to establish a Botanic Garden on the island. The site, he said, was selected on

Government land, and an annual grant of 300*l.* was placed on the estimates for the expense of preparing the ground and paying a superintendent, who has not yet been engaged. The sum appears small, but is really a considerable amount for an island which is small and far from wealthy.

MESSRS. WODDERSPOON AND CO., Serle Street, Lincoln's Inn, are publishing in one sheet on paper for sixpence, an easy guide to the principal constellations and stars visible in Great Britain. We have first a map of the circumpolar stars, and another showing those north and south of the equator; the guiding lines, by which the stars can be easily found from the instructions carefully given, being printed in red ink. It is very clear that the author has embodied in this cheap chart the results of much labour for the teaching of people uninstructed in such matters. We learn, indeed, that many copies have already been given away among coastguardsmen, labourers, and others, who, after a little instruction, use them greedily, and delight in having them to refer to. This is distinctly a good work, and we trust that some of our readers will follow it up.

WE hear that the reconstruction of the Naval Astronomical Observatory of Japan, which has been deferred for several years owing to the extraordinary outlay required, is to be commenced at once according to the plans originally prepared.

IT is stated that M. Paul Bert, the French physiologist, has been appointed Resident in Annam, Tonquin, and Cambodia.

A COMPLETE set of observations of the new star in Orion discovered by Mr. J. E. Gore on December 13, 1885, was, *Science* states, obtained at Harvard College Observatory on December 16—the very evening on which the despatch was received from Lord Crawford—settling the non-identity of the star with D.M. + 20°, 1172, the star named in the despatch. A meridian circle observation by Prof. Rogers gave for the position of the *nova* R.A. 5h. 49m. 4.25s., Decl. + 20° 9' 15" 6. Prof. Pickering's photometric measures made the magnitude 6.2, and the spectroscope showed the existence of bright bands. Two excellent photographs fixing the position of the star with reference to neighbouring stars were obtained, and one photograph of the spectrum. The indications are suggestive of the new star being a long-period variable, and there was a slight suspicion of a diminution in magnitude during the first six or seven hours it was under observation.

MR. WOOD-MASON has, it is stated, undertaken to prosecute a thorough inquiry into the silk-producing larvæ of India.

SOUTH-EASTERN ROUMELIA was visited on the evening of the 8th and morning of the 9th inst. by earthquake shocks, some of which were of a violent character. At Philippopolis the movement is described as being in a south-south-easterly direction.

ON December 29, 1885, there was an earthquake at Ismidt, in Asia Minor, not far from Constantinople. It took place at half-past one in the afternoon. The oscillations were slight, and passed from west to east.

AN interesting discovery of bronze hatchets and other prehistoric warlike instruments has been made at Llanwitt Major, Glamorganshire. As a number of workmen were engaged in digging a foundation for a building, they discovered three spear-heads, six hatchet-like celts, and several other interesting relics, which were concealed under an ancient wall. Some bones were also found. A further search is being organised.

SOME interest is being excited among geologists in Kent by the great depth to which a boring has been sunk at the Dover Guard Prison for a water supply. The boring, which is close to the sea, has now reached a depth of 1000 feet, being 700 feet below the sea-level.

THE additions to the Zoological Society's Gardens during the past week include a Lesser White-nosed Monkey (*Cercopithecus pelturista*) from West Africa, presented by Mr. T. Risely Griffith; a Gray Ichneumon (*Herpestes griseus*) from India, presented by Capt. J. Cutting; a Gray Squirrel (*Sciurus cinereus*) from North America, presented by Mrs. Charles Neck; a Golden Eagle (*Aquila chrysaetos*), European, presented by Mr. H. V. Knox; a Bronze-winged Pigeon (*Phaps chalcoptera*) from Australia, presented by Mr. Augustus F. Spry; a — Hang-nest (*Xanthosomus icterocephalus*) from Venezuela, a Song Thrush (*Turdus musicus*), British, deposited; a White-thighed Colobus (*Colobus vellerosus*), a Moustache Monkey (*Cercopithecus cephus*), a Ludio Monkey (*Cercopithecus ludio*) from West Africa, received in exchange.

OUR ASTRONOMICAL COLUMN

THE LEYDEN OBSERVATORY.—Prof. H. G. van de Sande Bakhuyzen has published his Report for the year ending September 15, 1885. The work to which the meridian circle was devoted during the year was the continuation of the observation of a selected list of fairly bright stars situated in the immediate neighbourhood of the Pole. It is expected that this series of observations will be finished off during the present winter. With the 7-inch refractor, nine observations of Wolf's comet were made. Between October 1884 and March 1885, a series of measures have been made with Airy's double-image micrometer attached to this equatorial, for the purpose of determining the systematic errors of the measures of the diameters of Mars and Uranus obtained in former years. For this purpose, Prof. Bakhuyzen has measured the diameters of artificial disks, formed by circular holes in a copper plate, made so as to resemble, both in size and brightness, the planets themselves. The results of these investigations will be published shortly. The reduction of the meridian observations, 1877-85, is in a forward state, some parts being nearly completed. This work is intrusted to Dr. E. F. van de Sande Bakhuyzen, the First Observer. Some progress has also been made in the reduction of the zone observations, 1874-76. Prof. Bakhuyzen himself has been chiefly occupied with his monograph on the rotation-period of Mars, now published. In March 1885 work was commenced in connection with the erection of the new 10½-inch objective, and the instrument is now ready for use. The mounting has been supplied by the Repsolds, and the object-glass by Alvan Clark and Sons. Its performance, so far as it has yet been tested, appears to be remarkably good, and does not compare unfavourably with that of other instruments of similar size. In Prof. Bakhuyzen's hands it will doubtless do good work.

FABRY'S COMET.—Dr. H. Oppenheim gives the following ephemeris for this comet for Berlin midnight:—

1886	R.A.	Decl.	Log Δ	Log r
	h. m. s.	° ' "		
Jan. 17 ...	23 31 4	+21 53'4	0'2304	0'2025
19 ...	23 29 58	22 5'3		
21 ...	23 28 58	22 18'2	0'2316	0'1857
23 ...	23 28 3	22 32'1		
25 ...	23 27 14	22 46'9	0'2319	0'1682

BROOKS'S COMET.—The following elements and ephemeris have been computed for this comet by Dr. J. Palisa:—

$T = 1885 \text{ Nov. } 28^{\text{h}} 24^{\text{m}} 36^{\text{s}}$ Berlin M.T.

$$\left. \begin{aligned} \pi &= 301^{\circ} 29' 50'' \\ \Omega &= 262^{\circ} 30' 48'' \\ i &= 42^{\circ} 31' 27'' \end{aligned} \right\} \text{Mean Eq. } 1886^{\circ} 0.$$

$$\log q = 0.04091$$

Error of the middle place (0 - C).

$$d\lambda \cos \beta = + 4''.7 \quad d\beta = 4''.5$$

Ephemeris for Berlin Midnight

1886	R.A.	Decl.	Log Δ	Log r	Bright- ness.
	h. m. s.	° ' "			
Jan. 14 ...	21 5 25	+12 8'6	0'2921	0'1261	0'74
18 ...	21 20 46	13 48'6	0'2989	0'1377	0'68
22 ...	21 35 48	15 25'2	0'3064	0'1495	0'62
26 ...	21 50 48	+16 57'4	0'3146	0'1614	0'57

The brightness on December 28 is taken as unity.

BARNARD'S COMET.—For Barnard's comet Dr. H. Oppenheim gives the following ephemeris, also for Berlin midnight:—

1886	R.A.	Decl.	Log Δ	Log r
	h. m. s.	° ' "		
Jan. 17 ...	2 37 45	+11 14'7	0'2136	0'3193
19 ...	2 34 22	11 38'4		
21 ...	2 31 8	12 2'5	0'2173	0'3068
23 ...	2 28 4	12 27'0		
25 ...	2 25 9	12 51'8	0'2213	0'2937

GORE'S NOVA ORIONIS.—Dr. Copeland, examining the spectrum of this object at Lord Crawford's Observatory, Dun Echt, finds distinct evidence of a spectrum of bright bands superposed on a well-marked spectrum of the third type; these bright bands corresponding to those ordinarily seen in cometary spectra, and obtained in the spectrum of a coal-gas flame.

ASTRONOMICAL PHENOMENA FOR THE WEEK 1886 JANUARY 17-23

(For the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

At Greenwich on January 17

Sun rises, 8h. 0m.; souths, 12h. 10m. 24'5s.; sets, 16h. 21m.; decl. on meridian, 20° 42' S.: Sidereal Time at Sunset, oh. 9m.

Moon (Full on January 20) rises, 13h. 53m.; souths, 21h. 44m.; sets, 5h. 39m.*; decl. on meridian, 18° 13' N.

Planet	Rises h. m.	Souths h. m.	Sets h. m.	Decl. on meridian
Mercury ...	6 40	10 36	14 32	22° 59' S.
Venus ...	9 12	14 39	20 6	7 14 S.
Mars ...	21 30*	4 0	10 30	5 9 N.
Jupiter ...	22 39*	4 38	10 37	1 6 S.
Saturn ...	14 15	22 25	6 35*	22 36 N.

* Indicates that the rising is that of the preceding evening and the setting that of the following morning.

Occultations of Stars by the Moon

Jan.	Star	Mag.	Disap. h. m.	Reap. h. m.	Corresponding angles from ver- tex to right for inverted image
17 ...	117 Tauri...	6	15 38	16 28	33 264°
18 ...	130 Tauri...	6	0 54	1 59	124 310
18 ...	26 Geminorum...	5½	20 37	21 44	43 271
20 ...	1 Cancrī ...	6	2 3	2 49	61 338
22 ...	37 Sextantis ...	6	19 16	20 7	33 224

Variable Stars

Star	R.A.	Decl.	h. m.
	h. m.	° ' "	
U Cephei ...	0 52'2	81 16 N.	Jan. 18, 0 2 m
			22, 23 41 m
Algol ...	3 0'8	40 31 N.	19, 20 0 m
ζ Geminorum ...	6 57'4	20 44 N.	18, 5 0 m
			23, 7 30 M
S Cancrī ...	8 37'4	19 27 N.	19, 3 23 m
δ Libræ ...	14 54'9	8 4 S.	19, 17 20 m
			22, 1 11 m
U Coronæ ...	15 13'6	32 4 N.	19, 23 6 m
U Ophiuchi ...	17 10'8	1 20 N.	17, 18 41 m
			and at intervals of 20 8
β Lyræ ...	18 45'9	30 14 N.	Jan. 19, 19 0 m
η Aquilæ ...	19 46'7	0 43 N.	17, 0 0 m
δ Cephei ...	22 24'9	57 50 N.	19, 0 0 M
			22, 19 0 m

M signifies maximum; m minimum.

MR. AITKEN ON DEW¹

THE first point referred to in this paper is the source of the vapour that condenses to form dew. A short historical sketch is given of the successive theories from time to time advanced on this point, showing how in early times dew was supposed to descend from the heavens, and then afterwards it was suggested that it rose from the earth, while Dr. Wells, who has justly been considered the great master of this

Abstract of Paper read before the Royal Society of Edinburgh on December 21, 1885, communicated by permission of the Council of the Society.